KP-10

External Keypad
Installation and Operation Manual

Part Number MN/KP10.IOM Revision 1

KP-10

External Keypad
Installation and Operation Manual

Comtech EF Data is an ISO 9001
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ABOUT THIS MANUAL

This manual provides installation and operation information for the Comtech EF Data KP-10 External Keypad. This is a technical document intended for earth station engineers, technicians, and operators responsible for the operation and maintenance of the KP-10 External Keypad.

CONVENTIONS AND REFERENCES

CAUTIONS AND WARNINGS

Indicates information critical for proper equipment function.

Indicates a hazardous situation that, if not avoided, may result in minor or moderate injury. CAUTION may also be used to indicate other unsafe practices or risks of property damage.

Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.

METRIC CONVERSION

Metric conversion information is located on the inside back cover of this manual. This information is provided to assist the operator in cross-referencing English to Metric conversions.

RECOMMENDED STANDARD DESIGNATIONS

Recommended Standard (RS) Designations have been superseded by the new designation of the Electronic Industries Association (EIA). References to the old designations are shown only when depicting actual text displayed on the screen of the unit (RS-232, RS-485, etc.). All other references in the manual will be shown with the EIA designations (EIA-232, EIA-485, etc.) only.

TRADEMARKS

All product names mentioned in this manual may be trademarks or registered trademarks of their respective companies and are hereby acknowledged.

REPORTING COMMENTS OR SUGGESTIONS CONCERNING THIS MANUAL

Comments and suggestions regarding the content and design of this manual will be appreciated. To submit comments, please contact the Comtech EF Data Customer Support Department.

EMC COMPLIANCE

This is a Class A product. In a domestic environment, it may cause radio interference that requires the user to take adequate protection measures.

EN55022 COMPLIANCE

This equipment meets the radio disturbance characteristic specifications for information technology equipment as defined in EN55022.

EN50082-1 COMPLIANCE

This equipment meets the electromagnetic compatibility/generic immunity standard as defined in EN50082-1.

FEDERAL COMMUNICATIONS COMMISSION (FCC)

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.

This equipment generates, uses, and can radiate radio frequency energy. If not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference; in which case, users are required to correct the interference at their own expense.

Note: To ensure compliance, properly shielded cables for DATA I/O shall be used. More specifically, these cables shall be shielded from end to end, ensuring a continuous shield.

SAFETY COMPLIANCE

EN 60950

Applicable testing is routinely performed as a condition of manufacturing on all units to ensure compliance with safety requirements of EN60950.

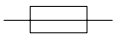
This equipment meets the Safety of Information Technology Equipment specification as defined in EN60950.

LOW VOLTAGE DIRECTIVE (LVD)

The following information is applicable for the European Low Voltage Directive (EN60950):

<HAR>	Type of power cord required for use in the European Community.
	CAUTION: Double-pole/Neutral Fusing. ACHTUNG: Zweipolige bzw. Neutralleiter-Sicherung.

International Symbols:

Symbol	Definition
	Alternating Current.
	Fuse.

Symbol	Definition
	Protective Earth.
	Chassis Ground.

Note: For additional symbols, refer to “Cautions” listed earlier in this preface.

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This Comtech EF Data product is warranted against defects in material and workmanship for a period of two years from the date of shipment. During the warranty period, Comtech EF Data will, at its option, repair or replace products that prove to be defective.

For equipment under warranty, the customer is responsible for freight to Comtech EF Data and all related custom, taxes, tariffs, insurance, etc. Comtech EF Data is responsible for the freight charges **only** for return of the equipment from the factory to the customer. Comtech EF Data will return the equipment by the same method (i.e., Air, Express, Surface) as the equipment was sent to Comtech EF Data.

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The foregoing warranty shall not apply to defects resulting from improper installation or maintenance, abuse, unauthorized modification, or operation outside of environmental specifications for the product, or, for damages that occur due to improper repackaging of equipment for return to Comtech EF Data.

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Comtech EF Data has reviewed this manual thoroughly in order that it will be an easy-to-use guide to your equipment. All statements, technical information, and recommendations in this manual and in any guides or related documents are believed reliable, but the accuracy and completeness thereof are not guaranteed or warranted, and they are not intended to be, nor should they be understood to be, representations or warranties concerning the products described. Further, Comtech EF Data reserves the right to make changes in the specifications of the products described in this manual at any time without notice and without obligation to notify any person of such changes.

If you have any questions regarding the equipment or the information in this manual, please contact the Comtech EF Data Customer Support Department.

Chapter 1. INTRODUCTION

KP-10 External Keypad

This chapter describes the Comtech EF Data KP-10, including :

- Purpose and function
- Compatible equipment
- Physical characteristics

1.1 PURPOSE AND FUNCTION

The KP-10 is a handheld keypad that provides portable, external access for controlling Comtech EF Data Transceivers and Redundancy Switch Units.

The KP-10 is typically used for the initial set up, occasional changes to the configurations and routine maintenance status of RFT and KST satellite terminal systems. When the KP-10 is used with a redundant system, it is typically connected to a Comtech EF Data Redundancy Switch Unit, RJU, or a Redundancy Junction Unit, RJU.

Note: Permanent monitoring of RFTs is accomplished with a PC and the M&C System Monitor Software . Information about the M&C System Monitor Software is found in the installation and operation manuals for Comtech EF Data CST and KST terminals.

1.1.1 COMPATIBLE EQUIPMENT

The KP-10 works with the following Comtech EF Data products:

- RFT 500
- RFT 505
- RFT 700
- RFT 1200
- RFT 1225
- KST2000A/B/L
- RJU2000
- RSU-503
- RSU-503L

1.1.2 DESCRIPTION

The KP-10 includes the following features:

- Communications are block mode (quasi half-duplex).
- Remote controls and status information are transferred via an RS-232C or an RS-485 serial communications link .
- Commands and data are transferred on the remote control communications link as US ASCII -encoded character strings .

Figure 1 shows the elements of the KP-10:

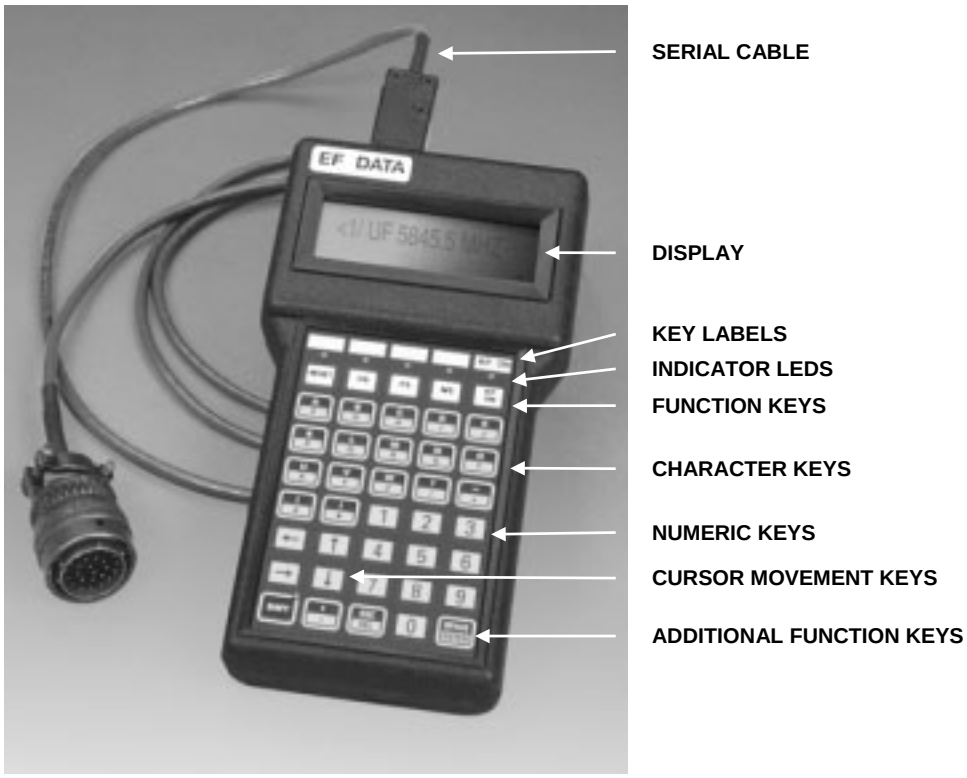

Figure 1. KP-10 Elements

Table 1 describes the elements of the KP-10.

Table 1. KP-10 Elements Descriptions

Element	Description
Display Screen	The display screen is a monochrome, four-line display screen featuring a user-controlled contrast level.
Key Labels	Blank, white key labels are located across the top of the keypad, just under the display screen.
Indicator LEDs	Indicator LED s above the function keys are used to signal that the key is in use, or that there are additional lines of a response message yet to be displayed.
Keypad	The keypad is a sealed-membrane type containing alpha-numeric keys, cursor movement keys, and specialized function keys.
Connector Port and Serial Cable	The KP-10 connects to RFTs and RSUs using either an RS-232C or an RS-485 serial communications port and cable. The serial connection type is an option selected when the KP-10 is ordered.

Chapter 2. CONFIGURATION

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2.1 KP-10 CONFIGURATIONS

The KP-10 is designed to operate with various RFT and KST Transceiver products. Additionally, the KP-10 can communicate using various serial data communication interfaces, such as RS-232, RS-485 and RS-422. Operation of the KP-10 with these products and data interfaces requires the selection of the proper KP-10 terminal and interface cable. Refer to Table 1 for the proper KP-10 configurations. Please note that not all combinations of products and interfaces are possible.

Table 2 KP-10 Configurations for Comtech EF Data Transceivers and Redundancy Units

	Data Interface		
Product	RS232	RS485	RS422
RFT500, RFT505, RFT700, RFT 1200, RFT1225, RSU503, RSU503L	KT/4856 Consisting of: Cable: PL/4873 Terminal: PP/QTERMIV-F079	KT/4856-1 Consisting of Cable: PL/5103 Terminal: PP/QTERMIV-F083	N/A
KST2000	KT/4856 Consisting of: Cable: PL/4873 Terminal: PP/QTERMIV-F079	KT/4856-1 Consisting of: Cable: PL/5103 Terminal: PP/QTERMIV-F083	KT/4856-2 Consisting of: Cable: PL/6158 Terminal: PP/QTERMIV-F123
KST2000A, B, or L	KT/8078 Consisting of: Cable: PL/8077-1 Terminal: PP/QTERMIV-F079	KT/8078-1 Consisting of Cable: PL/8075-1 Terminal: PP/QTERMIV-F083	KT/8078-2 Consisting of: Cable: PL/8076-1 Terminal: PP/QTERMIV-F123
RJU2000	N/A	KT/8078-1 Consisting of Cable: PL/8075-1 Terminal: PP/QTERMIV-F083	KT/8078-2 Consisting of: Cable: PL/8076-1 Terminal: PP/QTERMIV-F123

Tables 2, 3, and 4 show the pinouts on the KP-10 for the various data interfaces.

Table 3 KP-10 RS-232 Pinout

Pin Number	Function	I/O
2	RD/RX	INPUT
3	TD/TX	OUTPUT
5	GND	POWER RETURN
9	+V	POWER

Table 4 KP-10 RS-485 Pinout

in Number	Function	I/O
1	-RX/TX	DATA I/O
2	+RX/TX	DATA I/O
5	GND	POWER RETURN
9	+V	POWER

Table 5 KP-10 RS-422 Pinout

Pin Number	Function	I/0
1	-RX	INPUT
2	+RX	INPUT
3	+TX	OUTPUT
6	-TX	OUTPUT
5	GND	POWER RETURN
9	+V	POWER

Cable diagrams for the various interface cables can be found in Appendix C.

2.2 CONNECTING AND SUPPLYING POWER

Note: The KP-10 is not weather resistant. Please treat the terminal with the same care afforded a laptop computer.

Connecting the KP-10 is a matter of plugging the interface cable into both the KP-10 and the unit being controlled.

Power for the KP-10 is supplied from the RF terminal or redundant unit

The connection is a 9-pin female D connector located on the top of the KP-10.

To connect the KP-10 and supply power:

1. Plug the 9-pin connector into the receptacle on the top of the KP-10 (Figure 2).
2. Plug the 26-pin connector into the remote receptacle on the RFT (Figure 3), or into the J16 Monitor and Control receptacle on the RSU (Figure 4).

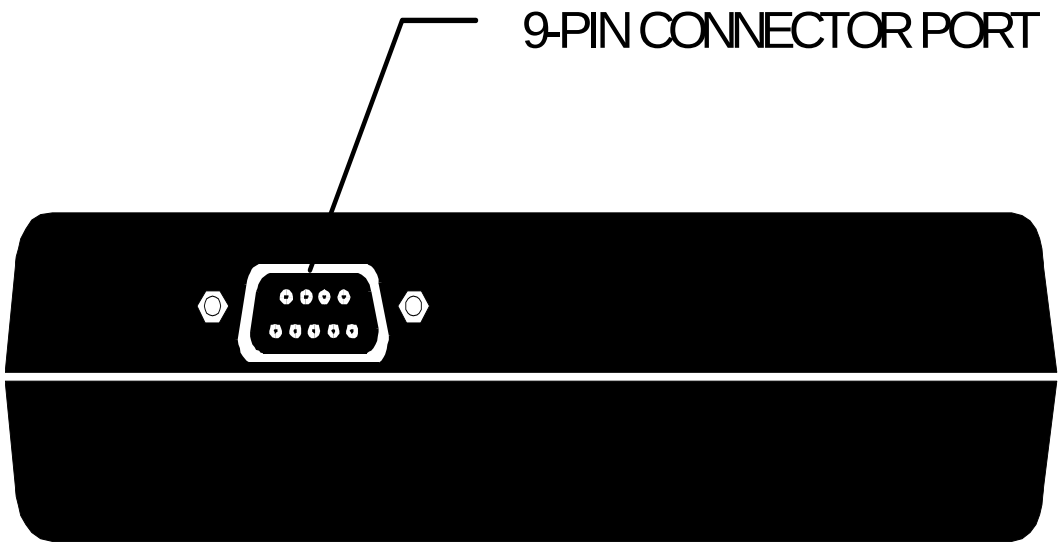

Figure 2. 9-Pin Connector Port on the KP-10 (Top View)

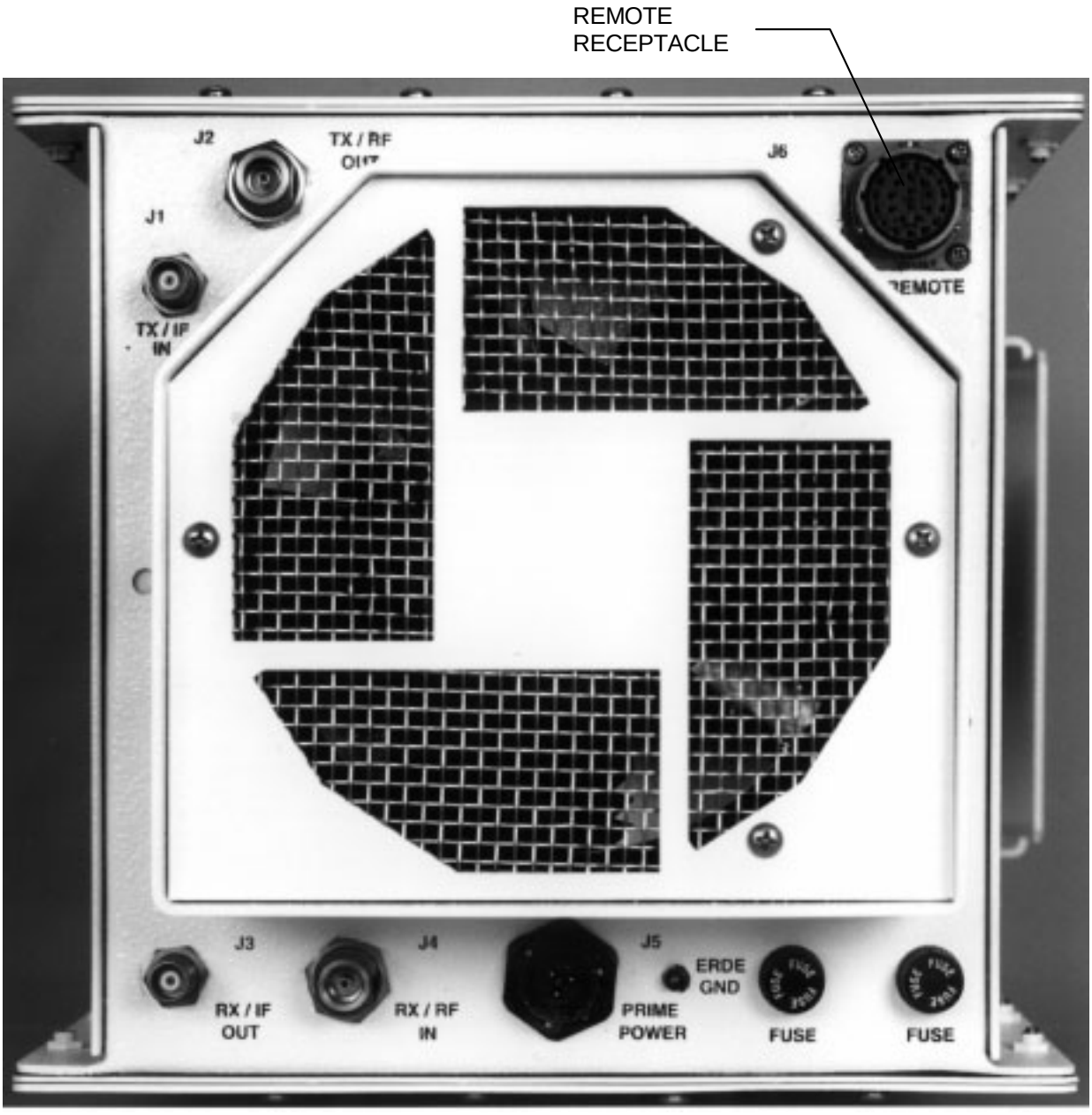

Figure 3. RFT-500 External Connections

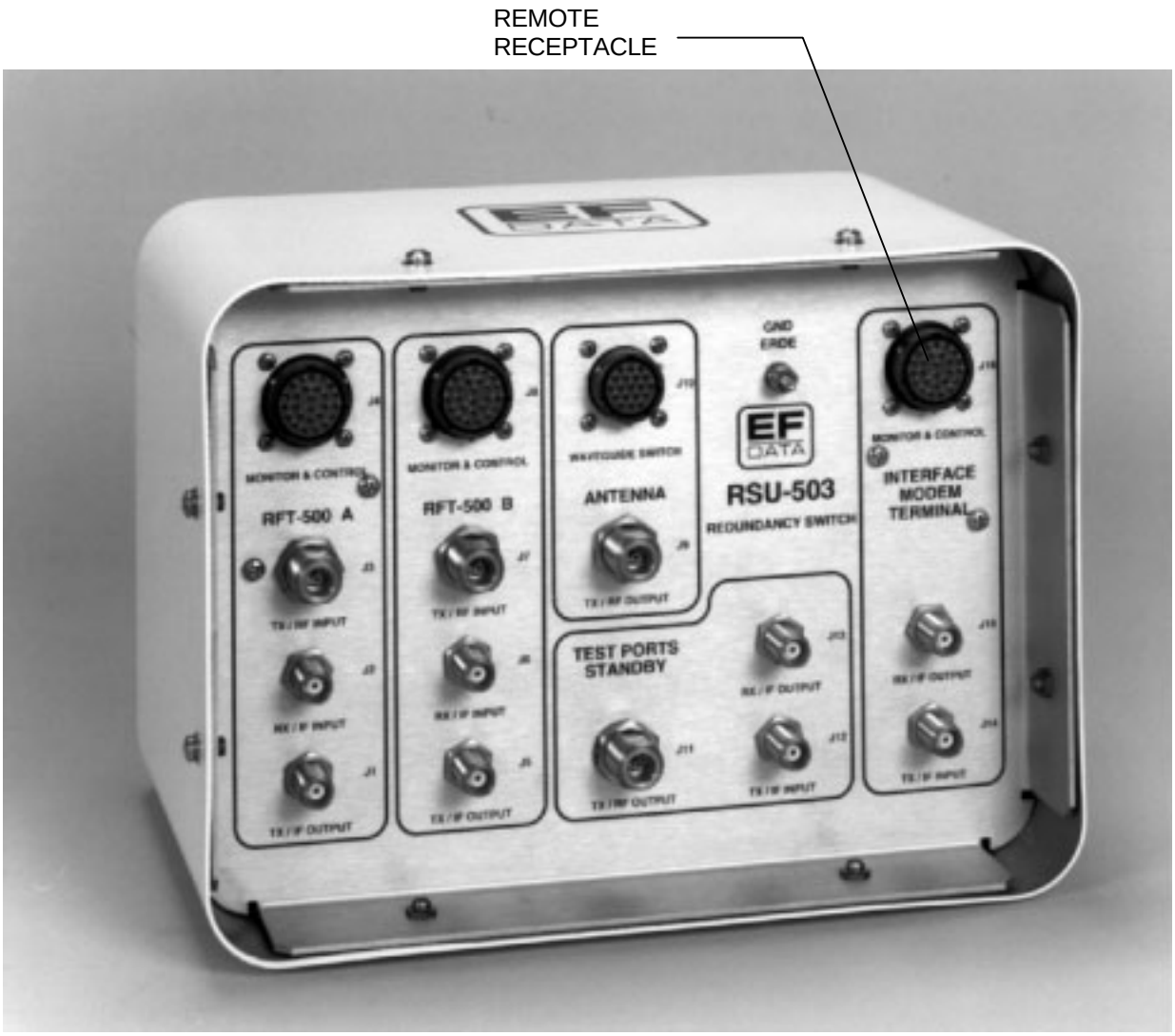

Figure 4. RSU-503 External Connections

During initial setup of a redundant system, connect the KP-10 to each component directly. After initial setup, it is possible to connect the KP-10 to the RSU, and access each component by selecting the individual component address.

Note: Connections for other RFTs and RSUs are similar. In case of a communication failure with the KP-10, disconnect the cable and then reconnect it, to perform a reset.

2.3 USING THE KEYPAD

2.3.1 FUNCTION KEYS

White function keys are the first row of keys on the top of the keypad (Figure 5). [OS], [FS], [MS], and [AS] are programmed to send specific, pre-set commands when pressed. [RESET], [SHIFT], and [ENTER] perform other operational functions. The function keys are described in Table 6.

Table 6. KP-10 Function Keys

Function Key	Function Performed
[RESET]	Press [RESET] to clear all messages and settings in the KP-10. Pressing [RESET] is equivalent to turning the unit off, and then on.
[OS] (Operating Status)	Press [OS] to access and display the operating status of the selected RFT.
[FS] (Fault Status)	Press [FS] to access and display the fault status of the selected RFT.
[MS] (Maintenance Status)	Press [MS] to access and display the maintenance status of the selected RFT.
[AS] (Switch Address)	Press [AS] to access and display the address of the selected RFT. Note: [AS] was formerly [KP ON]. [KP ON] is now obsolete.
[SHIFT]	Press and hold [SHIFT] in combination with any two-part key to enter the character depicted on top of the key.
[ENTER]	Press [ENTER] to send a command to the terminal.

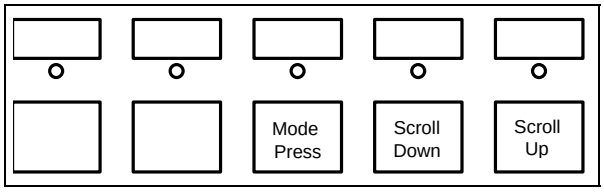

Figure 5. Alternate Key Functions During Configuration

Certain function keys perform alternate functions during the configuration process:

- [FS] serves as the [MODE] key
- [MS] serves as the [SCROLL UP] key
- [AS] serves as the [SCROLL DOWN] key

Table 7 shows keys used on permanent terminals that have been changed on the KP-10.

Table 7. Keys Changed on the KP-10

These keys on the permanent terminals:	Are changed to these keys on the KP-10:
+ (Plus key)	_ (Underscore key)
- (Minus key)	_ (Underscore key)
(and) (Parentheses keys)	< and > (Less than and greater than keys, respectively)
, (Comma key)	. (Period key)
(Spacebar key)	↵ (Enter key)
? (Question mark key)	/ (Backslash key)

2.3.2 CHARACTER KEYS

Character keys, containing the letters of the alphabet, are located just under the command keys. The character keys are two-part keys, containing two characters each. Simply press the key to enter the character shown on the lower half of the key.

To enter a character on the upper half of a two-part key:

1. Press and hold [SHIFT]. The [SHIFT] indicator LED glows when [SHIFT] is engaged.
2. Press the character key.

2.3.3 NUMERIC KEYS

Numeric keys, containing the numerals 0 through 9, are located below and to the right of the character keys. The numeric keys contain only one numeral each; therefore, entering numerals does not require use of the [SHIFT] key. Press the key to enter the numeral shown on the key.

2.3.4 CURSOR MOVEMENT KEYS

Cursor keys, containing directional arrows, are located below and to the left of the character keys. The cursor keys do not require use of the [SHIFT] key. Press the key to move the display screen cursor in the direction indicated by the arrow on the key.

2.4 CONFIGURING THE KP-10

Access the default configuration settings using either of these two methods:

- While pressing any key, supply power to the external keypad.
  or
- If power is already supplied, press [RESET] for a second.

The default configuration consists of several items:

- Version
- Contrast setting
- Baud rate
- Data format
- Serial mode

These items appear in a series of displays, each one accessed by pressing and releasing a key.

After the default configuration has been completed, the KP-10 is ready for input.

2.4.1 VERSION

After power-on, the Version (v1.1) appears on the display screen.

2.4.2 CONTRAST CONTROL

Release the key pressed during power-on to display “CONTRAST” on the screen.

- DARKER — Press [SCROLL UP] to darken the display screen contrast.
- LIGHTER — Press [SCROLL DOWN] to lighten the display screen contrast.

Note: See Figure 5 for scroll key locations.

2.4.3 COMMUNICATION MODE SETTINGS

Setting	Description
Baud Rate	Press [MODE] and the default Baud rate of 9600 appears. Change the Baud rate by pressing [SCROLL UP] or [SCROLL DOWN] to raise or lower the Baud rate.
Data Format	Press [MODE] again, and the data format appears. Do not change the setting of “7e2”.
Serial Mode	Press [MODE] a third time, and the serial mode “BLOCK” will appear. Do not change the setting of “BLOCK”.
Input Ready	Press [MODE] again, and the cursor moves to the upper left corner of the screen, indicating the terminal is ready to receive input.

Note: See Figure 5 for mode and scroll key locations.

2.5 ENTERING COMMANDS AND RECEIVING RESPONSES

Enter a command on the KP-10 keypad, then send it to the terminal by pressing [ENTER]. The command sent and the corresponding response returned from the terminal are both visible on the display screen.

To type a command:

1. Press firmly on each character key in sequence.
2. Verify the characters on the display screen. The message format must be valid (see Chapters 3 and 4 for information on valid message formats for single and redundant systems, respectively).
3. Press [ENTER] to send the completed command to the terminal.

On occasion, the response received from the accessed device is too large to fit on the display. When this happens, the indicator LED above [FS] or [RFS] flashes. The entire response can be viewed by *scrolling* through it. After scrolling through the message, press [ENTER], [RESET], [OS], [MS], or [AS] to turn off the flashing LED.

To scroll through a response:

1. Press the function key under the flashing LED.
2. Read the displayed section of the response.
3. If the LED is still on, press the function key again to see more of the message.

Chapter 3. OPERATION

Message Structure 15
Single RFT Communications 19
RSU Communications 21

This chapter describes:

- How to operate the KP-10 with a single RFT
- How to operate the KP-10 with an RSU
- How to enter commands and read responses
- Message structure and device addresses

3.1 MESSAGE STRUCTURE

When typing commands or reading responses, it is important to understand the valid message structure. An overview of valid message structure is presented here.

Messages on the KP-10 fall into the categories of *commands* and *responses*. Commands are messages which the KP-10 transmits to the RFT, while responses are messages returned by the RFT in response to a command.

To enter and send a command:

1. Type the command strings using the character and numeric keys.
2. Press [ENTER].

For details on specific commands and parameters, refer to the “Remote Control Operation” section in the installation and operation manual for the appropriate Comtech EF Data CST or KST system.

3.1.1 CHARACTER FORMAT

The ASCII character format used requires 11 bits/character:

- 1 start bit
- 7 information bits
- 1 parity bit
- 2 stop bits **(Note:** Default is “7e2”.)

3.1.2 START CHARACTER

Each message on the remote link begins with a *start character* and ends with an *end character*. The start and end characters are different for commands and responses.

The start characters are as follows:

- Commands: <
- Responses: >

3.1.3 DEVICE ADDRESSES

The *device address* is the address of the specific device that is designated to receive or respond to a transmitted command.

Table 8. Device Addresses

Valid Device Addresses	
Length	1 to 3 characters
Range	1 to 255

When using the KP-10 external keypad, the global address “*” is used to create a string output response displayed on the external keypad. This KP-10 global address causes the accessed device to respond, regardless of its specific address.

Do not confuse the KP-10 global address (*) with the global address of zero referred to in the M&C System Monitor Software User’s Guide. The zero global address causes the accessed device to accept commands without responding.

3.1.4 COMMAND MESSAGE STRUCTURE

The valid message structure varies according to whether the message is a command or a response. The command message structure is as follows:

Example: `<add/DCF_nnnn.n'cr']`

Start Character	Device Address	Command and Parameter	End Character
<	add/	DCF_nnnn.n	'cr']
	Replace 'add' with the valid device address, or use the KP-10 global address of '*' (for a single-system RFT only).	Command = DCF_ Parameter = nnnn.n	carriage return and end bracket

3.1.5 RESPONSE MESSAGE STRUCTURE

The response message structure is as follows:

Example: `>add/DCF_nnnn.n'cr''lf']`

Start Character	Device Address	Command, Parameter and Response	End Character
>	add/	DCF_nnnn.n'cr''lf'	]
	'add' is replaced by the valid device address, or the KP-10 global address of '*' (for a single-system RFT only)	Command = DCF_ Parameter = nnnn.n Response = 'lf'	End bracket

Replace parameter markers (such as “add”) with appropriate values. For more information about specific parameter values, refer to the “Remote Control Operation” section in the installation and operation manual for the appropriate Comtech EF Data CST or KST terminal system.

Note: “add” is a parameter marker that must be replaced with a valid 1 to 3 character device address in the range of 1 through 255, or the KP-10 global address of “*”.

Do not use any global address when accessing the RSU unit with the KP-10.

3.1.6 END CHARACTER

As stated previously, each message on the remote link begins with a *start character* and ends with an *end character*. The start and end characters are different for commands and responses.

The end characters are as follows:

- Commands “cr”] (carriage return and end bracket)
- Responses] (end bracket)

3.1.7 NEGATIVE RESPONSES

If the terminal receives a message which does not match the established protocol or cannot be implemented, a negative acknowledgment is sent in response.

Examples of negative responses include:

- >add/?ER1_PARITY ERROR'cr"lf']
  (Error message for received parity errors.)

- >add/?ER2_INVALID PARAMETER'cr"lf']
  (Error message for a recognized command which cannot be implemented or has parameters which are out of range.)

- >add/?ER3_UNRECOGNIZABLE COMMAND'cr"lf']
  (Error message for unrecognizable command or bad command syntax.)

- >add/?ER4_CONVERTER IN LOCK MODE'cr"lf']
  (Controller in Lock mode, must go to Enable mode first.)

- >add/?ER5_NOT SUPPORTED BY HARDWARE'cr"lf']
  (The command is a legal command, but is not supported by the current hardware configuration.)

3.2 SINGLE RFT COMMUNICATIONS

3.2.1 KEYPAD VARIATIONS FOR AN RFT

When the KP-10 is being used with a single-system RFT, the valid function keys are:

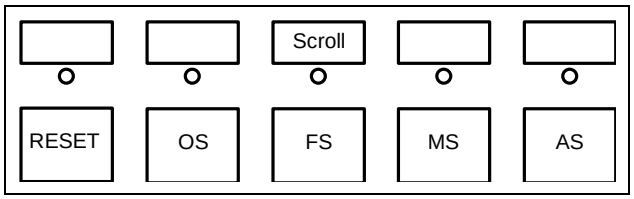

Figure 6. Function Keys for use with an RFT

Table 9. Descriptions of Function Keys used with an RFT

Function Key	Description
[RESET]	Reset External Keypad
[OS]	Switch Operation Status
[FS]	Switch Fault Status
[MS]	Switch Maintenance Status
[AS]	Switch Address (see Note) Note: The key labeled [KP ON] performs the [AS] function.

Make sure the [SHIFT] indicator LED is OFF before using these keys.

3.2.2 SINGLE SYSTEM ADDRESS

If the KP-10 is connected to a single RFT, the KP-10 global address of "*" is sufficient for communicating with the terminal. There is no need to ascertain the actual address of the RFT, in this case. A list of typical commands used with an RFT includes the following:

<add/	'UCF_'
<add/	'DCF_'
<add/	'RF_'
<add/	'UCA_'
<add/	'DCA_'
<add/	'AS_'
<add/	'BR_'
<add/	'PS_'
<add/	'RFJ_'
<add/	'CLNA_'
<add/	'FAN_'
<add/	'LFE_'
<add/	'SEL_'
<add/	'PGM_'
<add/	'CPGM_'
<add/	'XFE_'
<add/	'OS_'
<add/	'FS_'
<add/	'SF_'
<add/	'MS_'
<add/	'ET_'
<add/	'LM_'
<add/	'LPE_'
<add/	'RSW_'

Note: Replace "add" with the address of the device being accessed.

3.3 RSU COMMUNICATIONS

If the KP-10 is connected to a single RFT, the KP-10 global address of "*" is sufficient for communicating with the terminal. There is no need to ascertain the actual address of the RFT, in this case.

3.3.1 KP-10 KEYPAD VARIATIONS FOR AN RSU

When the KP-10 is being used with an RSU, the valid function keys are as follows:

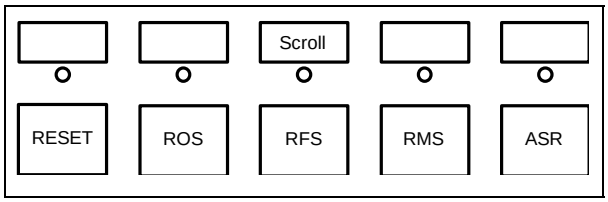

Figure 7. Function Keys for use with an RSU

Table 10. Descriptions of Function Keys used with an RSU

Function Key	Description
[RESET]	Reset External Keypad
[ROS]	Redundancy Switch Operation Status
[RFS]	Redundancy Switch Fault Status
[RMS]	Redundancy Switch Maintenance Status
[ASR]	Switch Address (See Note) Note: The key labeled [KP ON] performs the [ASR] function.

Make sure the [SHIFT] indicator LED is ON before using these keys.

3.3.2 MULTIPLE UNIT ADDRESSES

To communicate with each terminal via the RSU, the following format is used:

- <*/ASR_ (Meaning: RSU command - address 1)

In the previous example, the KP-10 is connected to an RSU. The global address command was sent first, then **AS** was pressed to access the address for a specific terminal before sending other commands.

In the following example, the address (2) of Terminal A follows "*":

- <*2/FS_ (Meaning: Terminal A command - address 2)

Note: Always make sure the correct address of any terminal (other than address 1) follows "*" in the command string.

A list of typical commands used with an RSU includes the following:

<add/	'ASA_'
<add/	'ASB_'
<add/	'ASR_'
<add/	'BR_'
<add/	'PS_'
<add/	'ULS_'
<add/	'ULM_'
<add/	'DLS_'
<add/	'DLM_'
<add/	'HWC_'
<add/	'ROS_'
<add/	'RFS_'
<add/	'RSF_'
<add/	'RMS_'
<add/	'ET_'
<add/	'POLL_'
<add/	'LM_'

Appendix A.
CABLES

Figure 1 CA/4873 ..... A–2
Figure 2 CA/5103 ..... A–3
Figure 3 CA/6158 ..... A–4
Figure 4 CA/8075 ..... A–5
Figure 5 CA/8076 ..... A–6
Figure 6 C/A 8077 ..... A–7

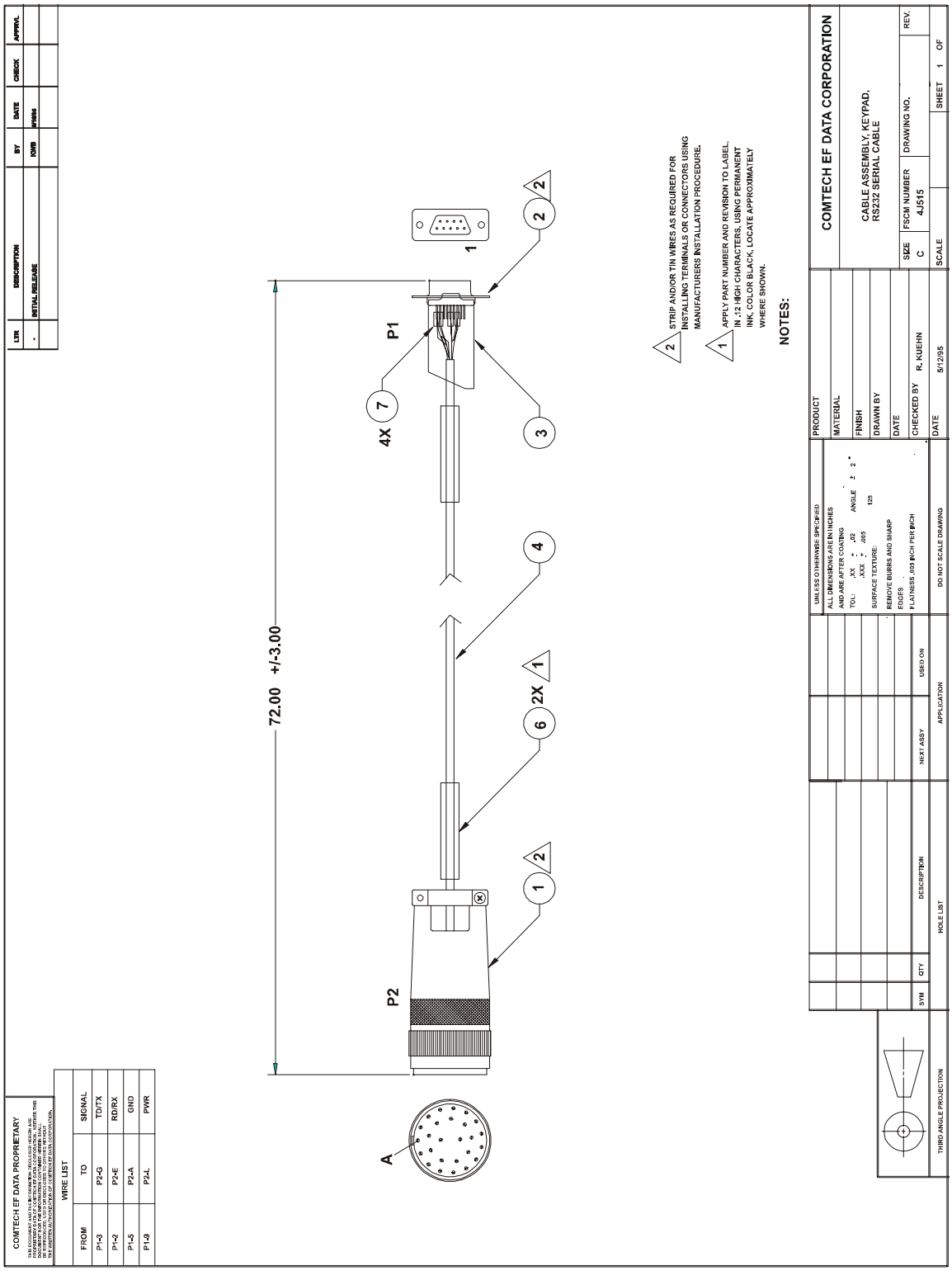

Figure 8 CA/4873

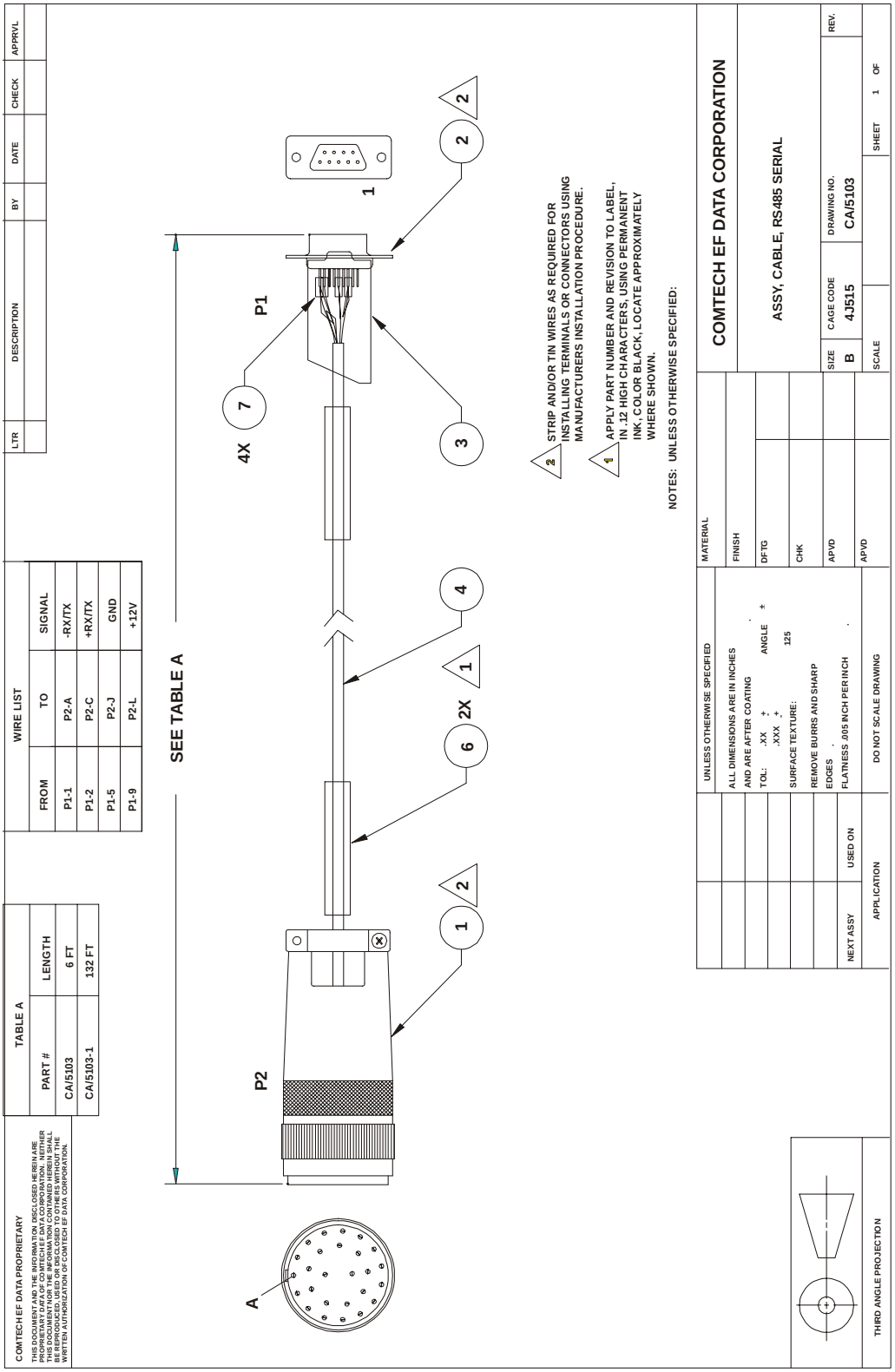

Figure 9 CA/5103

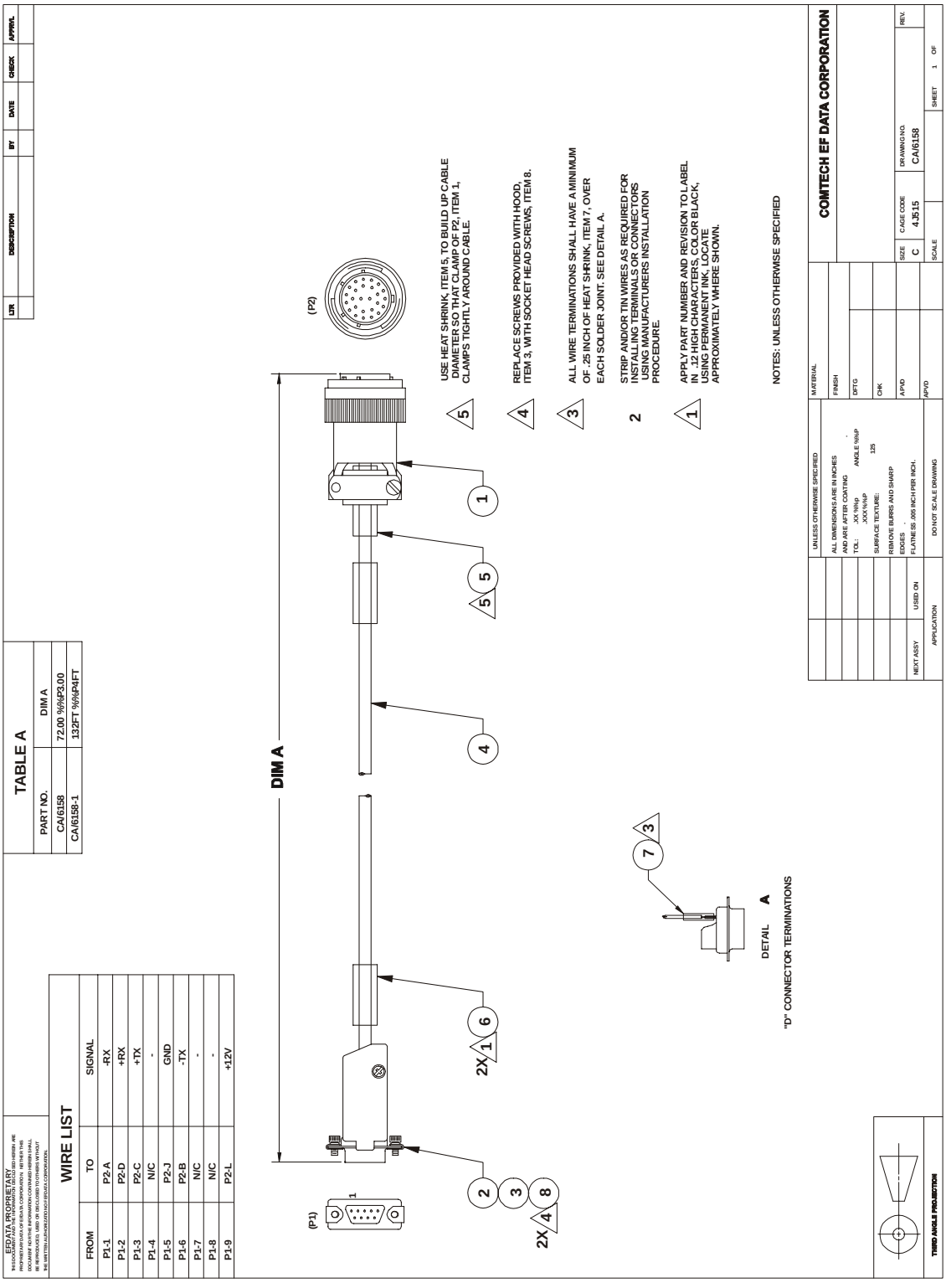

Figure 10 CA/6158

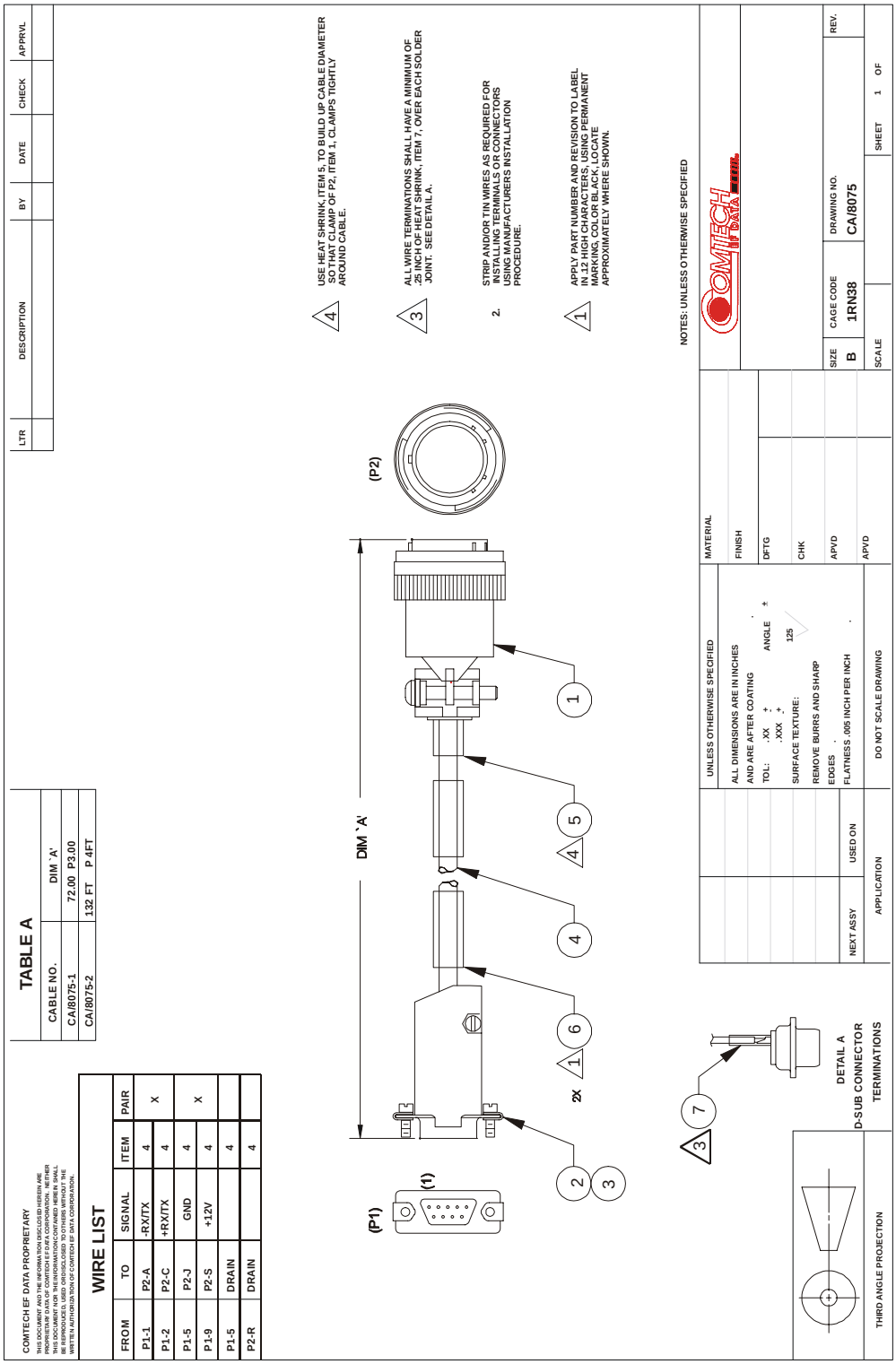

Figure 11 CA/8075

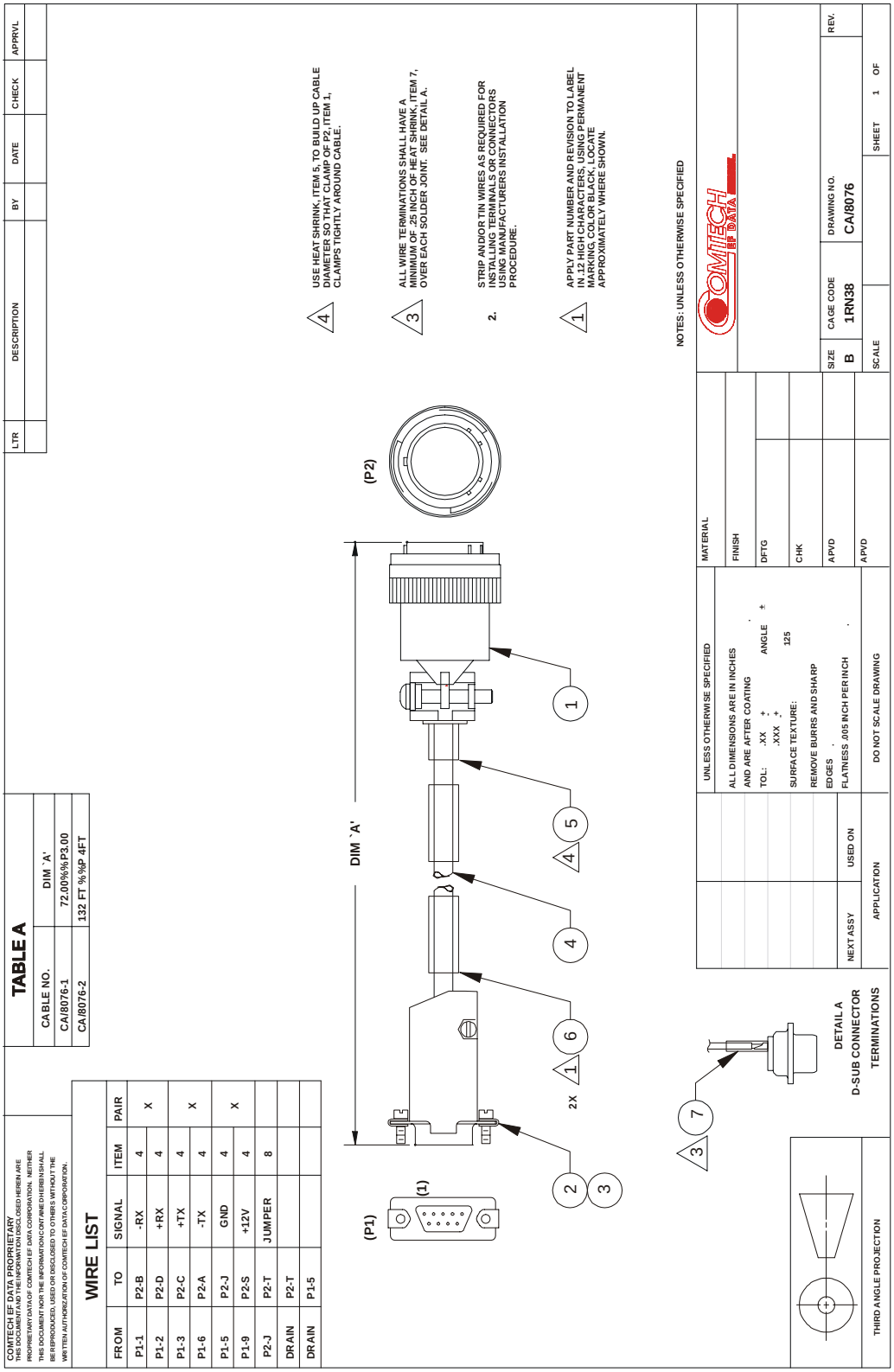

Figure 12 CA/8076

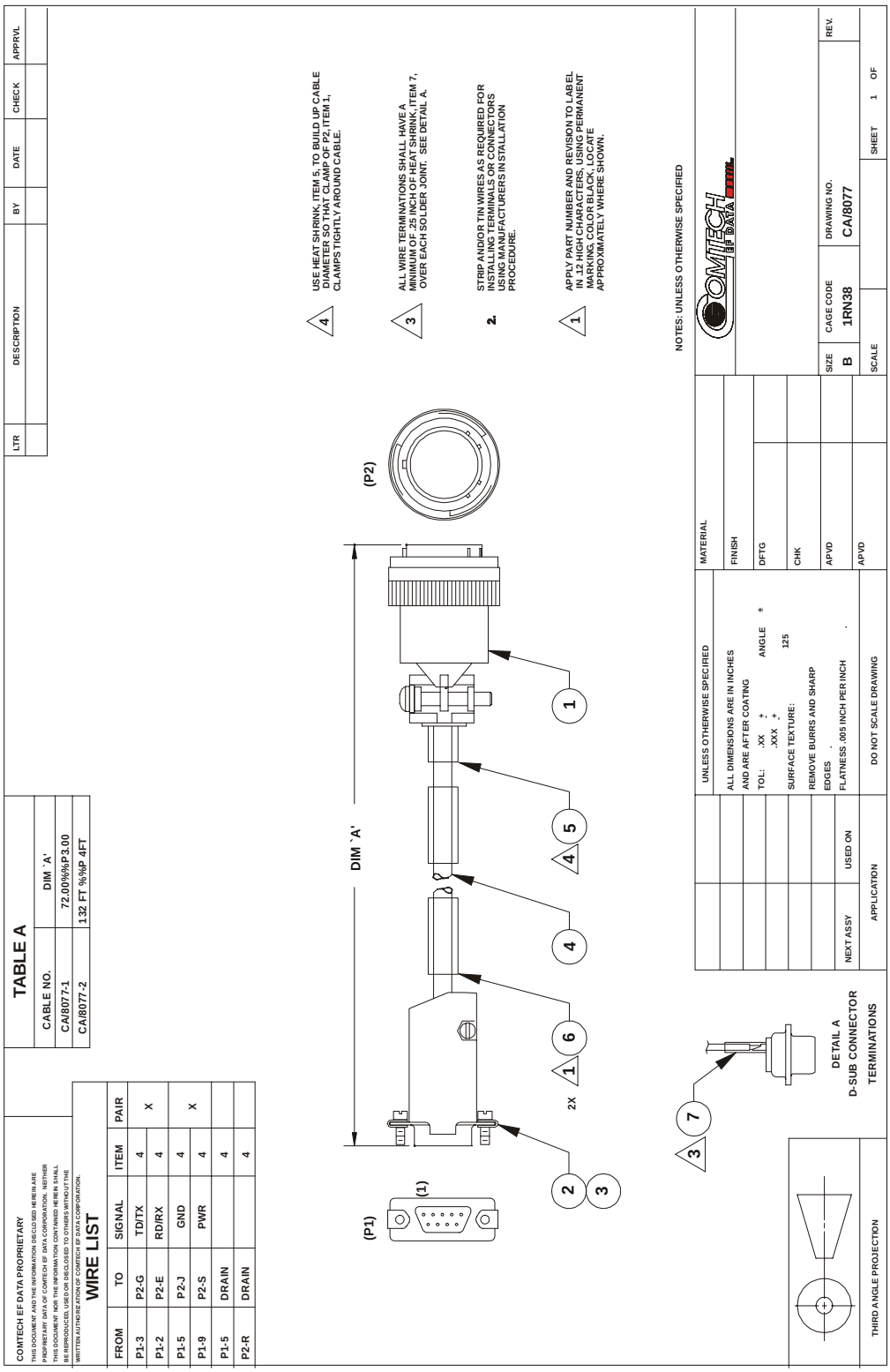

Figure 13 C/A 8077

METRIC CONVERSIONS

Units of Length

Unit	Centimeter	Inch	Foot	Yard	Mile	Meter	Kilometer	Millimeter
1 centimeter	—	0.3937	0.03281	0.01094	6.214×10^{-6}	0.01	—	—
1 inch	2.540	—	0.08333	0.2778	1.578×10^{-5}	0.254	—	25.4
1 foot	30.480	12.0	—	0.3333	1.893×10^{-4}	0.3048	—	—
1 yard	91.44	36.0	3.0	—	5.679×10^{-4}	0.9144	—	—
1 meter	100.0	39.37	3.281	1.094	6.214×10^{-4}	—	—	—
1 mile	1.609×10^{5}	6.336×10^{4}	5.280×10^{3}	1.760×10^{3}	—	1.609×10^{3}	1.609	—
1 mm	—	0.03937	—	—	—	—	—	—
1 kilometer	—	—	—	—	0.621	—	—	—

Temperature Conversions

Unit	° Fahrenheit	° Centigrade
32° Fahrenheit	—	0 (water freezes)
212° Fahrenheit	—	100 (water boils)
-459.6° Fahrenheit	—	273.1 (absolute 0)

Formulas
C = (F - 32) * 0.555
F = (C * 1.8) + 32

Units of Weight

Unit	Gram	Ounce Avoirdupois	Ounce Troy	Pound Avoir.	Pound Troy	Kilogram
1 gram	—	0.03527	0.03215	0.002205	0.002679	0.001
1 oz. avoir.	28.35	—	0.9115	0.0625	0.07595	0.02835
1 oz. troy	31.10	1.097	—	0.06857	0.08333	0.03110
1 lb. avoir.	453.6	16.0	14.58	—	1.215	0.4536
1 lb. Troy	373.2	13.17	12.0	0.8229	—	0.3732
1 kilogram	1.0×10^{3}	35.27	32.15	2.205	2.679	—

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